Preparation and Characterization of $Ag/TiO_{2-x}N_x$ Nanoparticles

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Abstract

The $Ag/TiO_{2-x}N_x$ nanoparticles were synthesized by photochemical deposition in a $TiO_{2-X}N_X$ suspension system. The prepared products were characterized by means of XRD, Uv-vis and photoluminescence spectra (PL). Its photocatalytic activity was investigated by the decomposition of methylene blue (MB) solution under illumination of visible and ultraviolet light, respectively. Compared to $TiO_{2-x}N_x$, the photocatalytic activity of the as–prepared $Ag/TiO_{2-x}N_x$ is obviously enhanced due to the decreasing recombination of a photoexcitated electron-hole pairs. The Mechanism in which photocatalytic activity is enhanced has been discussed in detail.

Keywords : Photocatalytic activity, $Ag/TiO_{2-x}N_x$, Photochemical deposition, Nanoparticles

1. Introduction

Titanium dioxide(TiO_2), the most promising photo-catalyst due to its potential application in the decomposition of pollutants in water and air, has attracted much attention for the past few decades. Its use under visible light or sunlight, however, was limited due to a relatively broad band gap and high recombination of photoexcitated electron-hole pairs. It is through simple and effective methods to decrease recombination efficiency that noble metal-doped or deposited titania is synthesized. Among them, Ag/TiO_2 has been more introduced by means of chemical reduction, photodeposition and dipping[1-4], whereas $Ag/TiO_{2-x}N_x$ has not been studied so far.

In this paper, $Ag/TiO_{2-x}N_x$ photocatalyst was synthesized by the photochemical reduction method starting from $TiO_{2-x}N_x$ nanoparticles prepared by sol-gel auto-igniting synthesis. The results indicated that photocatalytic activity of $Ag/TiO_{2-x}N_x$ was obviously improved both in ultraviolet and visible light region compared to $TiO_{2-x}N_x$.

2. Experimental and Results

The $Ag/TiO_{2-x}N_x$ photocatalysts were synthesized by photochemical deposition with acetone as hole-traps under the illumination of an electron saving-energy lamp, with a major emission at 545 nm(phlips, YPZ 220/14-2U.RR.D) starting from $TiO_{2-x}N_x$ prepared by sol-gel auto-igniting systhesize.

An X-ray diffractometer(RigakuD/Max-RB, Japan)with Cu K_a radiation (λ=0.15406 nm), Uv-vis diffuse reflectance spectrum(Cintra 10e Uv-vis spectrumeter) with $BaSO_4$ as substrates, Fluorescence spectraphotometer (F-4500) with an excitation wavelength of 340 nm, characterized the resulting samples.

In the suspension, the photocatalytic activity of the as-prepared powders were investigated by the decomposition of methylene blue (MB) under the illumination of an electron saving-energy lamp with a major emission at 545 nm(phlips, YPZ 220/14-2U.RR.D) and an ultraviolet lamp with a major emission located at 365 nm(250 W), respectively. In all experiments, prior to irradiation, the pH value of the MB solution was adjusted to 9.0~9.5.

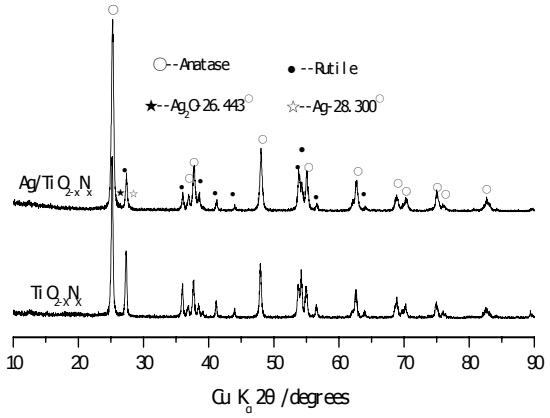

Fig. 1. XRD patterns of the as-prepared powders. The upper and bottom are corresponding to $Ag/TiO_{2-x}N_x$ and $TiO_{2-X}N_X$, respectively.

XRD analysis, Figure 1 shows the XRD patterns of the Ag-$TiO_{2-x}N_x$ and $TiO_{2-x}N_x$ nanoparticles. It is not difficult to see that their XRD patterns have no distinct difference. Both the $Ag/TiO_{2-x}N_x$ and $TiO_{2-x}N_x$ nanoparticles show co-existence of anatase and rutile phase, whereas lower

diffraction peaks of Ag_2O and Ag were detected near two theta equal to 26.443° and 28.300° for $Ag/TiO_{2-x}N_x$ powders, respectively.

Uv-vis diffusion reflectance, Shown in Figure 2 are the Uv-vis diffuse aborption spectras of the as-synthesized $Ag/TiO_{2-x}N_x$ and $TiO_{2-x}N_x$ powders. It can be seen that, Compared to both the spectras, the onset edges of photo-absorption is highly closer. The photoabsorbtion threshold for $Ag/TiO_{2-X}N_X$ and $TiO_{2-X}N_X$ powders is 428 nm and 430 nm, respectively, while that of deggusa p25 estimated using the same methods is 392nm.

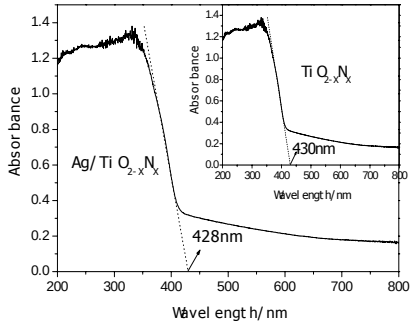

Fig. 2. Uv-vis diffuse absorption spectras the as-prepared of $TiO_{2-x}N_x$ and $Ag/TiO_{2-x}N_x$ powders.

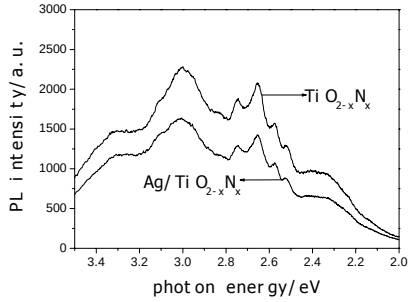

Fig. 3. PL spectra of the $Ag/TiO_{2-x}N_x$ and $TiO_{2-x}N_x$ nanoparticles.

Photoluminescence spectra, Figure 3 shows PL spectras of the prepared $Ag/TiO_{2-x}N_x$ and $TiO_{2-x}N_x$ nanoparticles. A broad band was observed for the two samples, respectively. It can be seen that the intensity of PL spectra for $Ag/TiO_{2-x}N_x$ is distinctly lower than that of $TiO_{2-x}N_x$, which indicates that recombination efficience of photoexcitated charge carries is decreased due to that Ag^0 was deposited on the surface and act as traps to capture the photoinduced electrons, inhibiting recombination of electron-hole pairs [5~7].

Photocatalytic activity, Figure 4 and Figure 5 show the photocatalytic decomposition of MB under the irradiation of ultraviolet and visible light. It is no difficult to see that, the photocatalytic activity of $Ag/TiO_{2-x}N_x$ particles is higher than that of $TiO_{2-x}N_x$ in irrespective ultraviolet and visible regions. It is, however, comparative to deggusa p25 in the ultraviolet region and far from better than that of deggusa p25 under the illumination of visible light.

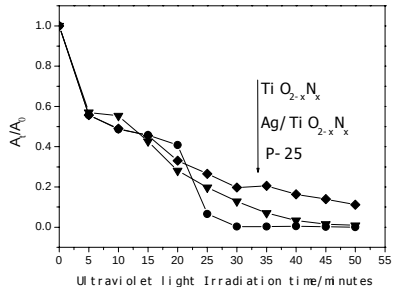

Fig. 4. The polts of A/A_0 of MB solution versus irradiation time under ultraviolet light.

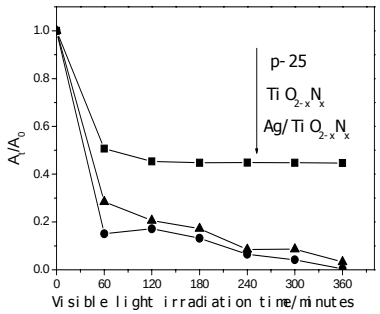

Fig. 5. The polts of A/A_0 of MB solution versus irradiation time under visble light.

3. Summary

The $Ag/TiO_{2-x}N_x$ particles were prepared using photo-chemical deposition starting from $TiO_{2-x}N_x$ nanoparticles under the irradiation of vislble light. The photocatalytic activity is enhanced because the Ag particles deposited act as electron traps and accelerate separation of hole-electron pairs, as is Ag/TiO_2 elsewhere.

4. References

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